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Optimization in Shipping of Products from Factories to Warehouses

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Abstract- Transportation and logistics management plays an important role in supply chain operations. Traditional methods of shipping products from factories to warehouses may lead to higher transportation cost and inefficient resource allocation. In this study, an optimization system using the Transportation Model is proposed to minimize transportation cost and improve logistics efficiency .
The solution uses techniques such as North-West Corner Method, Least Cost Method, Vogel's Approximation Method (VAM) and MODI Method for optimal product allocation and better decision making .
This paper presents a system for optimization in shipping products from factories to warehouses using the Transportation Model. The primary goal of this work is to improve accuracy and efficiency in transportation planning .

Keywords-Transportation Model, Logistics Management, Supply Chain, Optimization, Vogel's Approximation Method (VAM), MODI Method, Transportation Cost, Product Allocation, Operations Research, Warehouse Distribution

I. INTRODUCTION

Transportation of products from factories to warehouses is one of the most important activities in supply chain and logistics management. Industries must ensure that products are delivered efficiently with minimum transportation cost and proper allocation of resources. In real-world logistics systems, transportation planning becomes difficult when multiple factories, warehouses and transportation routes are involved [1],[2]. Improper planning may increase operational cost, delivery delays and inefficient utilization of resources.

Today many industries still depend on manual calculations, spreadsheets and traditional transportation planning methods. These methods may work for small scale distribution systems, but become difficult to manage for large logistics networks. Manual allocation of products and calculation of transportation costs can be time consuming and may increase the chances of errors [3],[5]. In many cases, managers may identify increased transportation expenses but may not know the most cost-effective allocation plan.

The solution to these problems is provided through Operations Research techniques such as the Transportation Model [4],[6]. The Transportation Model helps in determining the optimal quantity of products to be transported from each factory to each warehouse while satisfying supply and demand constraints. Methods like North-West Corner Method, Least Cost Method and Vogel's Approximation Method (VAM) are used to obtain the initial basic feasible solution, while MODI Method is used to determine the optimal transportation plan [6],[7]. These methods help industries reduce transportation cost, improve allocation efficiency and support better decision making in logistics operations.

Many researchers have proposed different optimization approaches for transportation and supply chain management. Some studies focused on improving allocation methods and reducing transportation costs using modified Vogel's Approximation techniques [4],[6]. Other studies discussed integrated inventory and transportation management systems for improving logistics efficiency and minimizing overall operational cost [2]. Research has also been carried out on dynamic supply chain monitoring and optimization to improve decision making and resource utilization in transportation systems [3].

This paper presents a system for optimization in shipping products from factories to warehouses using the Transportation Model. The system focuses on transportation cost calculation, optimal allocation of products and efficient utilization of supply and demand resources. The primary goal of this work is to reduce manual effort and improve accuracy, efficiency and control in transportation planning [1],[5]

The proposed system can be effectively applied in manufacturing industries, warehouse distribution systems and logistics companies where transportation cost optimization is essential. By using transportation optimization techniques, industries can improve productivity, reduce operational expenses and ensure better utilization of available resources. The study also highlights

the importance of applying mathematical optimization methods in real-world logistics and supply chain operations.

II. LITERATURE SURVEY

Erdal Akin et al. (2025) proposed a Deep Reinforcement Learning (DRL) based transportation framework for dynamic delivery systems using Unmanned Aerial Vehicles (UAVs). The study focused on minimizing delivery time and improving transportation efficiency in emergency medical delivery systems. Algorithms such as Deep Q-Network (DQN), Proximal Policy Optimization (PPO) and Advantage Actor-Critic (A2C) were implemented to optimize transportation routes and delivery scheduling under different constraints such as payload capacity and delivery time intervals. Experimental results showed that the PPO algorithm provided better and more stable performance when compared with other DRL methods. The study highlighted the importance of intelligent transportation optimization techniques in modern logistics and supply chain systems [1].

Lan Teng et al. (2019) presented an integrated inventory-transportation problem in Vendor Managed Inventory (VMI) systems. The study considered a distribution system consisting of a supplier, distribution center and multiple retailers. The objective was to minimize total logistics cost including inventory cost, transportation cost and time penalty cost. A mixed optimization algorithm based on simulated annealing and ant colony optimization techniques was proposed to improve transportation and inventory management efficiency. Computational experiments demonstrated that integrated transportation and inventory optimization significantly reduced operational cost and improved supply chain performance [2].

En-Zhi Cao et al. (2024) discussed the integration of inventory monitoring and capacity changes in dynamic supply chains with bullwhip and ripple effects. The study proposed a new inventory monitoring model for supply chain systems to analyze transportation fluctuations and operational disruptions. The research highlighted that demand fluctuations and transportation delays can affect the overall performance of supply chain systems. Control mechanisms were developed to reduce operational risks and improve transportation stability. The study concluded that effective transportation and inventory monitoring can enhance logistics decision making and improve supply chain efficiency [3].

Spencer Madamedon et al. (2022) proposed the Tiebreaker Vogel's Approximation Method (TBVAM) to improve the Initial Basic Feasible Solution (IBFS) of transportation problems. The method introduced a systematic tie-breaking procedure using maximum mean cost to overcome the limitations of the standard Vogel's Approximation Method (VAM). The proposed TBVAM algorithm was tested on benchmark transportation problems and compared with traditional VAM techniques. Results showed that TBVAM produced lower transportation cost and more optimal solutions. The study emphasized that proper allocation strategies and improved VAM techniques can significantly optimize logistics and transportation systems [4].

Bilqis Amaliah et al. (2025) investigated the impact of row arrangement in transportation problem matrices using the Supply Selection Method (SSM). The research focused on matrix preprocessing techniques to improve transportation cost optimization. Different row arrangement rules based on transportation cost values and supply values were tested to identify the most efficient arrangement for reducing total transportation cost. Experimental analysis on multiple transportation datasets showed that sorting rows according to the sum of transportation costs produced better allocation efficiency and minimized transportation expenses. The study highlighted the importance of preprocessing methods in transportation optimization problems [5].

Bilqis Amaliah et al. (2021) proposed the Two Highest Penalties (THP) method, a modified Vogel's Approximation Method to solve ambiguity problems in transportation optimization. Traditional VAM methods often produce multiple alternative solutions when equal penalty costs occur. To overcome this issue, the THP method selected the two highest penalties and used minimum cost-allocation techniques to determine the best allocation cell. Numerical analysis showed that the proposed THP method produced more accurate and near-optimal transportation solutions when compared with traditional VAM and LD-VAM methods. The research demonstrated the effectiveness of modified transportation optimization methods in reducing transportation cost [6].

Lokesh Kumar Bhuranda et al. (2022) introduced a modified approach for optimization of unbalanced fuzzy transportation problems. The study considered transportation problems involving uncertain transportation costs, supply and demand values represented using fuzzy numbers. Vogel's Approximation Method and modified ranking functions were applied to convert fuzzy transportation values into crisp values for optimization. The

proposed method improved transportation cost minimization and profit maximization under uncertain conditions. The research highlighted the importance of fuzzy optimization techniques in solving real-world transportation and logistics problems involving uncertainty and incomplete information [7].

Hawraa Mahdi Salih et al. (2023) proposed a system for improving file transferring in cloud computing using Vogel's Approximation Method (VAM). The study focused on reducing file transfer time and improving query performance by selecting the optimal server for file delivery in cloud systems. The proposed system consisted of cloud computing, server and client modules integrated with VAM optimization techniques. Experimental results showed that VAM significantly reduced transfer time and improved system efficiency when compared with traditional file transfer methods. The research demonstrated that transportation optimization techniques can also be effectively applied in cloud computing and data transfer systems [8].

Frederick S. Hillier and Gerald J. Lieberman explained the concepts of Operations Research and transportation optimization techniques using mathematical models. The book discussed important transportation optimization methods such as Transportation Model, North-West Corner Method, Least Cost Method, Vogel's Approximation Method (VAM) and MODI Method. The authors highlighted how mathematical optimization methods can be used to minimize transportation cost, improve allocation efficiency and support decision making in logistics and supply chain systems. The study also explained the importance of Operations Research techniques in solving real-world industrial and transportation management problems [9].

Table 1: Comparative analysis of reviewed CPM and PERT research papers

S.No	Research Paper	Technique / Methodology	Cost optimization	Allocation Accuracy	Supply-Demand Handling	Handling Uncertainty	Overall Score
1	Akin et al. (2025) [1]	DRL Based Transportation Framework	High	High	Medium	Very High	9
2	Teng et al. (2019) [2]	Integrated Inventory-Transportation Optimization	Very High	High	High	Medium	9
3	Cao et al. (2024) [3]	Inventory Monitoring & Capacity Control	Medium	High	Medium	High	8
4	Madamedon et al. (2022) [4]	Tiebreaker Vogel's Approximation Method	High	Very High	High	Medium	9
5	Amaliah et al. (2025) [5]	Supply Selection Method with Row Arrangement	High	High	High	Low	8
6	Amaliah et al. (2025) [5]	Two Highest Penalties Method (THP)	Very High	Very High	High	Medium	9
7	Bhuranda et al. (2022) [7]	Fuzzy Transportation Optimization using VAM	High	Medium	High	Very High	8
8	Salih et al. (2023) [8]	VAM based Cloud File Transfer Optimization	High	High	Medium	Medium	8
9	Hillier & Lieberman [9]	Transportation Model, VAM & MODI	Very High	Very High	Very High	Medium	10

III. FINDINGS

Based on a variety of studies which investigated transportation optimization and logistics management, it was found that efficient transportation planning is an essential factor for reducing transportation cost and improving supply chain performance [1],[2]. Most of the researchers agree that Transportation Models and Vogel's Approximation Method (VAM) are effective techniques for determining optimal allocation and minimizing transportation expenses [4],[6]. Methods such as North-West Corner Method, Least Cost Method and MODI Method also provide suitable solutions for transportation problems involving supply and demand constraints [7],[9].

Studies conducted by several researchers revealed that optimization techniques can significantly improve allocation accuracy, reduce operational delays and increase resource utilization efficiency in logistics systems. Some studies also highlighted that matrix preprocessing, inventory monitoring and integrated transportation systems help organizations improve decision making and overall logistics performance [2],[3],[5].

The literature review also demonstrated that advancements in technologies such as artificial intelligence, fuzzy logic, deep reinforcement learning and cloud computing are useful for improving transportation optimization and logistics efficiency [1],[7],[8]. These technologies help in handling uncertain transportation conditions, improving delivery performance and reducing transportation cost in large-scale distribution systems.

Overall conclusion from the surveyed research papers is that Transportation Models and Operations Research techniques are still highly applicable and efficient methods for solving real-world transportation and logistics management problems [4],[6],[9].

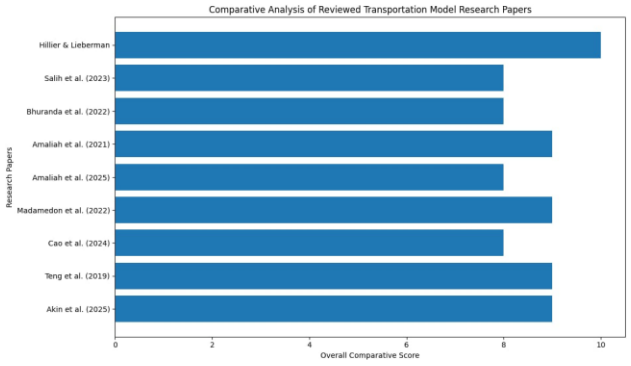

Fig 1: Analysis of Existing Transportation Optimization Techniques

IV. CONCLUSION

It has been concluded that Transportation Model and Operations Research techniques are useful for improving transportation planning and logistics management [1],[9]. Methods such as North-West Corner Method, Least Cost Method, Vogel's Approximation Method (VAM) and MODI Method help in minimizing transportation cost and improving allocation efficiency [4],[6]. The proposed system reduces manual calculations involved in transportation planning and helps in efficient allocation of products from factories to warehouses [2],[5]. Advanced techniques such as artificial intelligence, fuzzy optimization and cloud systems also improve transportation efficiency and decision making [1],[7],[8].

Therefore, the proposed Transportation Optimization System is an effective and simple method for solving real-world transportation and logistics management problems. The system helps industries reduce operational cost and improve supply chain efficiency [3],[4].

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